MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

PPH 0125 – MECHANICS

(All sections / Groups)

8 OCTOBER 2016
9.00 a.m - 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 4 pages excluding the cover page and the appendices with **FIVE** questions only.
2. Attempt **ALL** questions. Distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. All necessary workings must be shown.

Answer **ALL** questions.

Question 1: [10 marks]

Referring to Figure Q1, the coefficient of friction between the 3.0 kg block and the surface of track is 0.40. The system begins to move from rest at point *O*. Will the 3 kg block hit the pulley at the end of the track? Justify your answer.

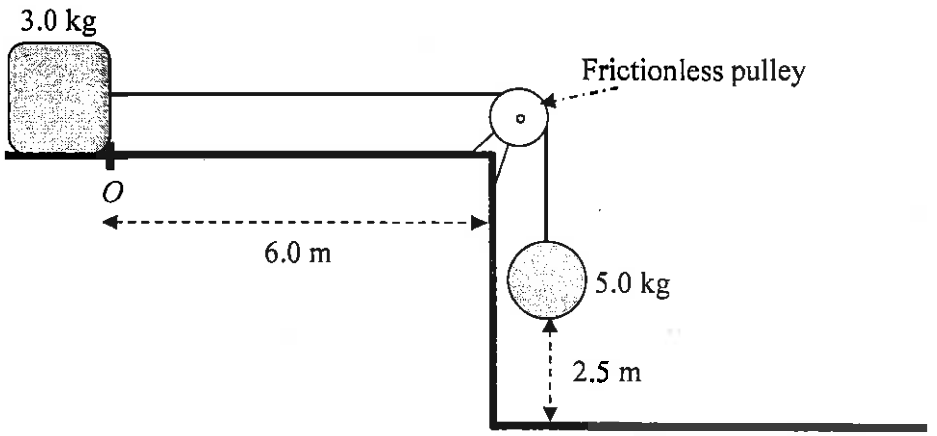

Figure Q1

(10 marks)

Question 2: [10 marks]

a) A solid sphere of moment of inertia $I = 0.5M$, where M is the mass of the sphere, can be rotated about an axis through its center by a torque of 20.8 N.m which accelerate it uniformly from rest through a total of 200 revolutions in 12.0 s.

i) What is the mass of the sphere ?

(3.5 marks)

ii) What is the angular speed when it has rotated 200 revolutions ?

(1.5 marks)

Continued...

b) A uniform stick 1.0 m long with a total mass of 270 g is pivoted at its center. A 3.0 g bullet is shot through the stick midway between the pivot and one end. The bullet approaches at 250 m/s and leaves at 140 m/s as shown in Figure Q2a and Figure Q2b respectively. With what angular speed is the stick spinning after the collision ?

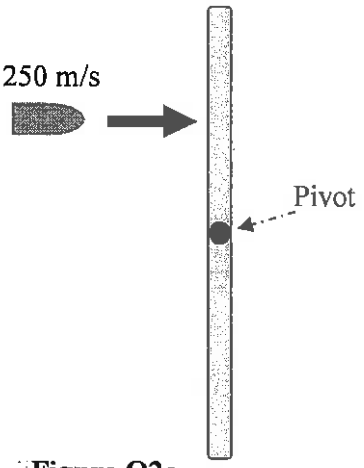

Figure Q2a

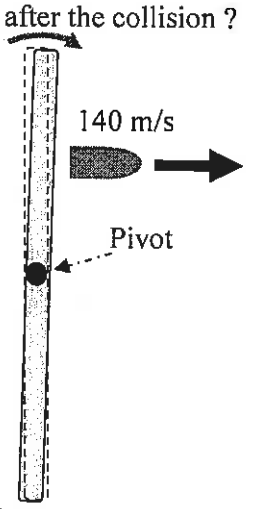

Figure Q2b

(5 marks)

Question 3: [10 marks]

a) Moon, Earth and Sun are located in a straight line as shown as in Figure Q3 below.

Figure Q3

i) Determine the gravitational force acting on the Earth due to the Moon.

(2 marks)

ii) Determine the gravitational force acting on the Earth due to the Sun.

(2 marks)

iii) Determine the net force acting on the Earth due to the gravitational attraction of the Moon and the Sun.

(1 mark)

b) A 750 kg military satellite is in a circular orbit 35000 km above the Earth surface.

i) What is the speed of the satellite in orbit?

(2 marks)

ii) Find the minimum kinetic energy for this satellite to escape the the Earth from this orbit.

(3 marks)

Continued...

Question 4: [10 marks]

a) State briefly the Young's modulus of a material.

(1 mark)

b) An advertisement sign (1500 kg) hangs from the end of a vertical aluminum girder with a cross-sectional area of 0.015 m^2. (Young's modulus of aluminum = 70 x 10^9 N/m^2)

i) Determine the stress within the girder.

(1 mark)

ii) Determine the strain on the girder.

(1 mark)

iii) The lengthened girder is 20.0 m, find its original length. (keep your answer in 4 decimal places.)

(3 marks)

c) A wooden boat of mass 120 kg has base dimension 4.0 m by 1.5 m and depth 0.9 m.

i) How deep will it sink in seawater. (density of seawater = 1020 kg/m^3)

(2 marks)

ii) Determine the weight of the load that causes 2/3 of the wooden boat sink into seawater.

(2 marks)

Continued...

Question 5: [10 marks]

A mass of 250 g oscillates with simple harmonic along the x-axis at a frequency of 4 Hz. Its displacement (in meter) from the equilibrium position varies with time (in second) according to the equation:

$$x(t) = 0.4 \sin\left(\omega t + \frac{\pi}{2}\right)$$

a) Does the mass passes through the equilibrium position at $t = 0$? Explain it.

(2 marks)

b) Determine the amplitude and angular frequency of the motion.

(2 marks)

c) Determine the equation velocity and acceleration.

(2 marks)

d) Determine the value of velocity, and acceleration when $t = 1.2\ s$.

(2 marks)

e) How long will it take to reach equilibrium position for the first time?

(2 marks)

End of Paper

APPENDIX I

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N.m^2/kg^2
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_o	-13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J.s
Speed of light in vacuum	c	3.0×10^8 m/s
Rydberg constant	R_H	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	9.81 m /s^2
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing	I_o	1.0×10^{-12} W /m^2
Coulomb constant	k	8.988×10^9 N m^2 /C^2
Permittivity of free space	ε_o/κ_o	8.85×10^{-12} C^2/N.m^2
Permeability of free space	μ_o	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:

One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

Earth:

Gravity	=	9.80 m s^{-2}
Radius	=	6.38 x 10^6 m
Mass	=	5.98 x 10^{24} kg

Moon:

Mass	=	7.35 x 10^{22} kg
Radius	=	1.74 x 10^6 m

Sun:

Mass	=	1.99 x 10^{30} kg
Radius	=	6.96 x 10^8 m

Mean distance from:

Sun to Earth	=	1.50 x 10^{11} m
Moon to Earth	=	3.85 x 10^8 m

APPENDIX II

List of Formulas

$y = kx^n$ $\quad \frac{dy}{dx} = knx^{n-1}$

$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$ $\quad \cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$ $\quad \tan\theta = \frac{\text{opposite}}{\text{adjacent}}$

$v = v_o + gt$ $\quad y - y_o = v_o t + \frac{1}{2}gt^2$ $\quad v^2 = v_o^2 + 2g(y - y_o)$ $\quad y - y_o = \left(\frac{v_o + v}{2}\right)t$

$a_c = \frac{v^2}{r}$ $\quad F_g = G\frac{m_1 m_2}{r^2}$ $\quad U_g = -G\frac{m_1 m_2}{r}$ $\quad T^2 = K_s r^3$

$\tau = r \times F$ $\quad \sum\tau = \tau_{net} = I\alpha$ $\quad I = \sum mr^2$ $\quad v = r\omega$

$L = r \times p = I\omega$ $\quad K = \frac{1}{2}I\omega^2$ $\quad |\tau| = |r||F|\sin\theta$

$T_s = 2\pi\sqrt{\frac{m}{k}}$ $\quad T_p = 2\pi\sqrt{\frac{l}{g}}$ $\quad T = \frac{2\pi}{\omega} = \frac{1}{f}$ $\quad \bar{y} = \frac{\sum_{i=1}^{N} m_i y_i}{\sum_{i=1}^{N} m_i}$

$x = A\cos\omega t$ $\quad x = A\sin\omega t$

$v = -\omega A\sin\omega t$ $\quad v = \omega A\cos\omega t$ $\quad W_F = |r||F|\cos\theta$

$a = -\omega^2 A\cos\omega t$ $\quad a = -\omega^2 A\sin\omega t$

$v = \frac{\Delta x}{\Delta t}$ $\quad a = \frac{\Delta v}{\Delta t}$ $\quad I = \sum_{i=1}^{N} m_i r_i^2$

$v = v_o + at$ $\quad x - x_o = v_o t + \frac{1}{2}at^2$ $\quad v^2 = v_o^2 + 2a(x - x_o)$ $\quad x - x_o = \left(\frac{v_o + v}{2}\right)t$

$W = mg$ $\quad \sum F = F_{net} = ma$ $\quad f_s \le \mu_S F_N$ $\quad f_k = \mu_K F_N$

$p = mv$ $\quad \sum F = \frac{\Delta p}{\Delta t}$ $\quad \Sigma W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ $\quad m_1u_1 + m_2u_2 = (m_1 + m_2)v$ $\quad P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$

$K = \frac{1}{2}mv^2$ $\quad PE_s = \frac{1}{2}kx^2$ $\quad F_s = -kx$ $\quad PE_G = mgy$

$\bar{x} = \frac{\sum_{i=1}^{N} m_i x_i}{\sum_{i=1}^{N} m_i}$ $\quad W_{Fs} = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$